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PATENT SPECIFICATION

412,407

Application Date: June 13, 1933. No. 16,891/33.

Complete Left: Feb. 27, 1934.

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PROVISIONAL SPECIFICATION.

Improvements in Apparatus for Extracting Weeds Roots or the like from the Ground.

I, HERBERT ALFRED HUMPHREY, Consulting Engineer, of 60, Frant Road, Tunbridge Wells, in the County of Kent, a British subject, do hereby declare the nature of this invention to be as follows:—

The kind of weed extractor in present use is of the rigid type, having a cutting edge which is pressed into the ground and on being withdrawn removes from the ground a cylinder of earth of practically uniform section containing the weed and root or portions thereof. The cutting edge is usually circular and any single apparatus cuts always the same diameter hole in the ground irrespective of the size of the weed or the nature of its root. This limitation has great disadvantages, for in most cases the apparatus cuts out either too much or too little earth and the cylindrical piece of earth removed rarely conforms to the economical shape required to remove any particular weed and its roots with the minimum of attached earth.

My invention overcomes these disadvantages and provides an apparatus for extracting weeds roots or the like from the ground in such manner as will remove the minimum of earth consistent with efficiency of eradication and so that a single apparatus is adaptable to various sizes of weeds and to the shape of the weed and shape and depth of its roots.

According to my invention I employ two or more converging members attached to a frame, handle or handles and means of causing the members to converge in the ground so as to remove therefrom a portion of earth enclosing the weed and its roots of suitable and economical shape so that the weed and its roots are effectively extracted with the least disturbance to the ground. My invention also comprises means of adjusting the opening between the members and the relative motions by which they converge together.

Generally two converging members taking the form of spades, forks, grabs or the like are sufficient, and their relative movements may be varied or adjusted e.g. as described below, to suit the nature of the root to be extracted for example weeds with deep vertical roots or with shallow spreading roots.

One member may be rigidly attached to the frame and the other member caused to converge towards it or both members may have movements relatively to the frame. Means may be provided for giving a rotational movement to the members for the purpose of more readily freeing the portion of earth to be removed from the adjacent earth or for cutting or tearing away the weed roots. Means are also provided for holding the members in any relative positions during portions of a complete operation and also for returning the members to the positions required for commencing a new cycle of operations. Means of facilitating the ejection of the removed earth and weed may be also included.

To reduce the force exerted by the operator to a minimum I may arrange for the converging members to be operated through reduction means or mechanism so that the operator applying power by hand or by foot moves said hand or foot through a greater distance than that moved through by the converging members.

Further in the case of strong roots and after the converging members have closed about the roots it may be desirable for their final extraction to employ force through a lever or equivalent device. For such purpose I may attach to the apparatus a fulcrum or rolling fulcrum or cam.

I will describe a simple example of an apparatus adapted to extract various shapes of earth to suit the size of weed and depth of root. Take two main levers, cross them and pivotally connect them like a pair of scissors. Imagine them held vertically with two ends upwards which we will call the handles. To the ends which point downwards pivotally attach the pair of opposed converging members which are to perform the cutting or digging. Let each digging member have an extension on the opposite side of its pivot and join this by a link to another pivotal point chosen on that main lever to which the member is not itself pivotted. If the chosen point is on the

handle side of the main lever and if the two members were originally inclined downward and inwards then a closing motion of the main levers, like the action of cutting with scissors, will not only cause the digging members to converge together but will rotate them into a more vertical position. If the digging members were in contact with the surface of the ground at the start then the closing of the main levers while they are pressed downwards will result in the digging members taking a downward curved path into the ground until the two converging members meet together both being then in an almost vertical position. On lifting the apparatus upwards the earth excavated will be the shape of a V with curved sides. Now imagine the extension of a digging member being pivotally linked to a point of the same main lever but on the point side, instead of the handle side, of the scissors. Then instead of the digging members being rotated towards the vertical they will be rotated towards the horizontal and the cycle of operations in the ground will result in a shallow trough-shaped portion of earth being removed. As the linking may take place at any chosen points in the whole lever system a wide variety of movements is obtained by the digging members as they converge in the ground.

The shape, structure, and material of the converging members should be adapted to the nature of the ground and of the weeds etc. to be extracted and the apparatus may have such members made detachable so that they can be replaced by members of other shapes or sizes.

It is desirable that for any given movement of the converging members their shape should be such that they cause a minimum displacement of the earth, in other words their shape should be dependent on the path of travel.

13th June, 1933.

H. A. HUMPHREY.

COMPLETE SPECIFICATION.

Improvements in Apparatus for Extracting Weeds Roots or the like from the Ground.

I, HERBERT ALFRED HUMPHREY, Consulting Engineer, of 60, Frant Road, Tunbridge Wells, in the County of Kent, a British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The kind of weed extractor in present use is of the rigid type, having a cutting edge which is pressed into the ground and on being withdrawn removes from the ground a cylinder of earth of practically uniform section containing the weed and root or portions thereof. The cutting edge is usually circular and any single apparatus cuts always the same diameter hole in the ground irrespective of the size of the weed or the nature of its root. This limitation has great disadvantages, for in most cases the apparatus cuts out either too much or too little earth and the cylindrical piece of earth removed rarely conforms to the economical shape required to remove any particular weed and its roots with the minimum of attached earth.

According to my invention, I employ two or more cutting members attached to a frame, provided with a handle or handles or otherwise adapted to receive downwardly applied pressure to cause the cutting members to penetrate the ground. The cutting members are mounted so that they converge as they penetrate the earth and thus enclose a tapered plug of earth containing the weed etc., the converging movement being a free movement caused solely by the reaction of the soil, or a constrained movement imposed by the mechanism of the frame or by both the frame mechanism and the soil reaction. In any case each cutting member follows a path in the earth which is a smooth continuation of the cutting surface and the earth enclosed between the cutting members is not substantially compressed.

In an alternative arrangement in which the cutting members are carried on pivoted arms, the distance of the pivot (or pivots) above ground level when the cutting members are buried in the earth being greater than the effective length of the cutting members, the cutting members follow substantially the line of least resistance corresponding to a smooth continuation of the cutting surfaces.

It will be evident that the invention ensures that a clean cutting action is obtained and, on lifting the tool after the cutting members have converged to the desired extent, the weed is extracted with practically no disturbance of the surrounding soil. The taper plug of earth represents the practical minimum of soil to be removed that is consistent with efficient eradication. The cutting mem-

bers need not move together although, as a rule, this is the most convenient arrangement.

The cutting members may be of various shapes, e.g. they may have plane or curved surfaces, with or without perforations or prongs. Generally segments of a hollow cone, for example half cones, provide suitable cutting members, and may be arranged so that when they have completely converged in the ground their edges register along their whole length. The depth to which the cutters penetrate the soil is determined by the angle of the cone and the distance apart of the points of the cutters when they start to penetrate the ground.

One member may be rigidly attached to the frame and the other member caused to converge towards it or both members may have movements relatively to the frame. Means may be provided for giving a rotational movement to the members for the purpose of more readily freeing the portion of earth to be removed from the adjacent earth or for cutting or tearing away the weed roots. Means are also provided for holding the members in any relative positions during portions of a complete operation and also for returning the members to the positions required for commencing a new cycle of operations. Means of facilitating the ejection of the removed earth and weed may be also included.

To reduce the force exerted by the operator to a minimum I may arrange for the cutting members to be operated through reduction means or mechanism so that the operator applying power by hand or foot moves said hand or foot through a greater distance than that moved through by the cutting members.

It will tend to a clear understanding of the invention if I classify the examples to be described under four headings, namely

1. Apparatus in which the converging of the cutting members is constrained by the mechanism to follow a definite path. This path, for the cutters employed, is that which offers the least resistance to penetration of the earth.

2. Apparatus in which the cutters are provided with the required degree of freedom and are caused to converge by the resistance of the earth to displacement which imposes an advance of the cutters along the path of least resistance to penetration.

3. Apparatus in which the converging of the cutters is controlled directionally by the earth resistance but the forward movement along the path of least resistance to penetration is assisted by the mechanism.

4. Where the ground is too hard to admit of penetration of the cutters by a downwardly applied pressure, such as manual operation can conveniently exert, then the cone of earth may be cut out by developing the conical surface by rotating one or more inclined knives which are fixed to a rotating portion of the apparatus at the angle of the desired cone.

Typical examples of my invention will now be described in the order of the above classification, and with reference to the accompanying drawings. Fig. I shows an elevation and Fig. II a plan of an apparatus in which the handle 1 is rigidly attached to the cutter 2 and to the arm 9 which carries the pivot 6. The second cutter 3 is connected through radius arms 4 and 5 and pivot 6 so that it is free to move in a circular path about pivot 6. In operation the lower point of cutter 2 is placed in contact with the surface of the ground and then forced into the ground to the desired depth by foot pressure on pedal 7 guided along its curved path and assisted by the operator using handle 1. Cutter 3 which remains above the soil surface is now pressed by foot pedal 8 into the earth and caused to converge towards cutter 2 until they meet and enclose between them the root and earth to be extracted. By lifting the apparatus or by moving the handle to the left until the pivot bearing comes into contact with the ground and serves as a fulcrum the earth enclosed in the cutters is removed from the surrounding earth. The operation is completed by rotating cutter 3 so that with the cutters separated the contents are easily discharged and the apparatus is ready for a fresh cycle. When the apparatus is to be used by aged or infirm people a pair of small perambulator wheels are fitted to carry the weight of the apparatus. The apparatus may be modified by hinging both cutters to the frame the hinges being on opposite sides so that the rotation of the cutters causes them to converge as they are forced into the ground. Also by suitable linking the cutters may be hand operated instead of foot operated.

A type of apparatus in which the converging cutters are guided by a frame or its equivalent so that they may be forced into the ground at a fixed angle is shewn in Fig. III. The frame is composed of the central tube 1 to which is rigidly attached the casting 2 which is bored with cylindrical holes at an appropriate angle and in which slide the tubes 3 and 4 carrying the cutters 5 and 6 respectively. A sleeve 7 slides over tube 1 and carries

two lugs to which links 8 and 9 are connected at their top extremities, their lower ends being pivotally connected to the tubes 3 and 4 as shown. A small tube 10 is carried inside tube 1 and projects downwards beyond tube 1 to an extent determined by the position of a handle 11 which can be moved to engage any of the slots 18 in tube 1 and is shown on the drawing as engaged in the highest slot. At the lower end of tube 10 is a disc 12 with a spike 13.

The operation is as follows:—The sleeve 7 is drawn upwards so that the tubes 3 and 4 are at the top of their strokes as limited by the set screws 14 and 15 which cannot pass beyond the ends of the slots 16 and 17 cut in the bored portions of casting 2. If a deep root is to be extracted tube 10 is set in a high position but for more shallow roots tube 10 is positioned lower relatively to the frame. The apparatus is now held vertically above the weed to be extracted and lowered until the spike 13 penetrates the centre of the weed and the weight of the apparatus rests upon the disc 12. The sleeve 7 is now forced downwards causing the cutters to penetrate the earth and converge therein until they meet. If the cutters are semi-conical they will contain a cone of earth in which the root to be extracted will be buried. The apparatus is now lifted up, the sleeve 7 moved upwards and the root discharged. The disc 12 helps to discharge the weed and earth as the cutters move past it on their back-stroke. It will be observed that the height of the frame above the surface of the ground determines the horizontal distance between the cutters when their points first strike the surface of the soil and therefore likewise determines the depth in the soil at which the cutters meet and the size of the cone of earth extracted.

Another example of apparatus in which the motion of the cutters is constrained by the mechanism is shown in Fig. IV. In this case the apparatus is adapted to extract a useful plant and its roots from the earth and to transplant it in fresh soil in another position. The halves 1 and 2 of a tubular frame are hinged together at 3 and can be locked by a nut in any relative position. The frame carries hinges at 5 and 6 which can also be locked to set the cutter guides 7 and 8, likewise hinged at 5 and 6, to any desired angle. The guides provide a sliding surface over which the arms 9 and 10 slide and which carry the cutters 11 and 12 at their lower extremities. Handles 13 and 14 are used to force the cutters into the ground along the chosen angle. As wide variation in size of plants has to be provided for the parts 9 and 10 can, without dismantling either cutters or handles, be slid clear of the guides and a different pair of arms and cutters, e.g. larger or smaller, slid into position. This is possible, by using such a section of guide and arm as is shewn shaded. Lock nuts are provided at 15 and 16 to keep the cutters closed during the removal of the plant from its original to its new position.

Some typical examples of the second class of apparatus will now be described. Figs. V and VI show a front and side elevation respectively of a type of apparatus in which the resistive force of the earth is used to cause the cutters to converge while they are being forced into the ground. The handle 1 is rigidly attached to a casting 2 the two lower portions of which provide guides in which run two pairs of rollers 3 and 4 which in turn carry the cutters 5 and 6. The guides are approximately at right-angles to the direction in which the cutters are forced into the earth. The links 7 and 8, connected to rollers 3, 4, the rod 9 and the pawl 10 serve to determine the opening between the cutters which can be set to any desired distance according to the size of weed and depth of root to be extracted. In operation the handle is held vertically and the points of the separated cutters allowed to touch the surface of the soil; then pressure on the handle 1 forces the cutters into the ground. If the rollers were frictionless the forces on the cutters would remain always in the direction of the advance of the cutters into the ground. To the extent to which the arrangement is not frictionless, the resistance of the earth to displacement, as distinct from cutting, has to be relied upon to control the cutters so that they advance at a constant angle to one another until they meet in the ground. During the closing of the cutters the links 7 and 8 push the rod 9 upwards and the pawl 10 engages notches at a higher level and prevents the cutters from opening until the root has to be discharged, the pawl being then released by hand. Ball bearings can be used instead of the rollers shewn in the drawing, and their path of travel can be made steeper, without altering the angle of the cutters, so as to counteract the effect of friction.

In Fig. VII the semi-conical cutters 1 and 2 are carried by the tubes 3 and 4 which are hinged at 5 and provided with handles 6 and 7. The points of the cutters are placed on the ground so that the weed to be excavated is between them and pressure on the handles forces the cutters into the ground. The resistance

of the earth causes the cutters to converge until they meet, and it will be noted that the cutters follow substantially the path of least resistance to penetration. As the cutters 1 and 2 are fixed to the tubes 3 and 4, and the latter are hinged at 5, the path of the cutters will deviate from the path of least resistance to the extent of a few degrees, but this is immaterial as far as the action of the tool is concerned.

The rod 8 is fixed to tube 4 but passes through a hole in tube 3 and carries a nut 9 which limits the movement of tube 3 away from tube 4. A thin wedge 10 passes through a slot in rod 8 and is pressed downwards by a spring so that as the cutters converge the wedge moves downwards and prevents the cutters from separating until the excavated weed has to be released when the wedge is pulled upwards by the knob 11. The apparatus is shown fitted with a weed ejector. By pressing the small handle 12 downwards the spring separated parts 13 and 14, attached to sliding sleeve 15 and moved downwards by rod 16, engage any weed or earth which may stick to the cutters and eject them.

In Fig. VIII the semi-conical cutters 1 and 2 are carried by the tubes 3 and 4 which are hinged at 5 and 6 to a cross bar 7 rigidly fastened to a central tube 8 at the top of which is fixed the operating handle 9. The points of the cutters are opened to the desired distance and placed on the ground with the weed to be excavated between them, and downward pressure on the handle forces the cutters into the earth. As in the case of Fig. VII, the cutters deviate slightly from the path of least resistance, owing to the fact that the hinges 5 and 6 are fixed relatively to one another. The extent of the deviation depends upon the vertical distance between these hinges and the points of the cutters, and can be reduced to a negligible amount.

The shapes of the cutters in Figs. VII and VIII are shown as straight-sided cones. Theoretically, because the cutters are hinged, a curve would be the correct shape, but as the distance between the cutter and its pivot increases the curve gets nearer a straight line. By making the distance of the pivots above the ground level, when the cutters are buried in the earth, greater than the effective length of the cutters, and by arranging the cutter-arms so that they are vertical half-way through the cutting stroke, the theoretical shape of the cutters becomes so close to a straight line cone that the breadth of an ink line covers the curve in the case of Fig. VII and almost covers the curve in Fig. VIII. In practice the cones are made straight-sided as the practical results in the two examples illustrated are indistinguishable from those of theoretically shaped cutters. As the cutters are free to follow substantially the path of least resistance to penetration the resistance of the earth causes the cutters to converge till they meet. On lifting the apparatus a cone of earth containing the weed is removed from the ground. A metal strip 10 rides across the rectangular tubes 3, 4 and 8 and is connected to a similar strip at the opposite side of the tubes by the two pairs of pins 11 and 12. These pins control the distance between tubes 3 and 4 which are pressed apart by springs 13 and 14, attached to the ejector blades 15 and 16. The vertical position of the strip 10 is controlled by the handle 17 which is connected through a slot in tube 8 to a rod 18 inside the tube which joins handle 17 and strip 10 rigidly together. A slot 19 in tube 8 accommodates a suitable connection between rod 18 and strip 10. A long vertical spiral spring inside tube 8 stretched between the points 20 and 21 tends to raise strip 10 so that as the cutters 5 and 6 converge the strip rises upwards thus keeping pins 11 and 12 pressed against the fins 22 and 23, fixed to tubes 3 and 4 respectively. Cutters 5 and 6 are in this manner held closed until the weed has to be ejected. By moving handle 17 and strip 10 downwards the pins 11 and 12 move down the inclined fins until they reach the bottom of the fins and at this point tubes 3 and 4 are allowed to be pressed apart to their widest opening. Already the ejector blades have commenced to push or scrape the earth and weed from the cutters and further downward motion of handle 17 completes the ejection. Handle 17 is now raised until strip 10 reaches a position which limits the distance between the cutters to that desired for starting a fresh cycle.

Very small apparatus constructed in accordance with my invention may be used for so called "pricking out" of seedlings. Fig. IX shows a suitable form for this purpose. The small cutters 1 and 2 are carried by metal strips 3 and 4 which are connected by links 5 and 6 pivoted at 7 and 8. The other ends of the links have pivots 9 and 10 moving in the vertical slots shown. The links are joined by a central pivot so that parts 3 and 4 are always kept parallel. The rings 11 and 12 are provided to take a finger and thumb of the operator who places the cutters so that the points touch the soil with the seedling between them and then presses vertically downwards till the

cutters guided by the soil meet together with the seedling and root between them. The thumb and finger then hold the cutters together during the process of transplanting the seedling into fresh soil after which the thumb and finger are gradually separated while the cutters are withdrawn to leave the seedling in its new position.

In Fig. X the handles 1 and 2 are attached to vertical tubes 3 and 4 which carry the cutters 9 and 10. Links 5, 6, 7 and 8 connect the tubes 3 and 4 in such manner that tubes 3 and 4 must remain parallel. This is secured by pivoting the links 5 and 6 at their top ends and links 7 and 8 at their lower ends to the tubes as shown. The other ends of the links have pins which ride in slots 11 and 12 cut in the tubes. Each pair of links is pivoted together at the centres 13 and 14 where they cross. In this arrangement only the vertical components of the forces applied to the handles 1 and 2 can reach the cutters 9 and 10 as any other components balance out through the connecting links. In this case therefore the converging of the cutters is solely due to the resistive action of the earth upon the cutters. The required degree of freedom is provided so that the cutters follow the path of least resistance to penetration of the earth. In the illustration tubes 3 and 4 are of rectangular section and are forced apart by spring 15 riding over a distance rod 16 which is pivoted to tube 4 at 17. Rod 16 passes loosely through tube 3 while tubes 3 and 4 are approaching but is gripped and held by a pair of spring-controlled friction cams 18 and 19 which act in one direction only so that tubes 3 and 4 are prevented from separating. After the cutters have met in the ground and the apparatus has been lifted along with an extracted weed the cams are released by pressing towards one another thumb and finger discs 20 and 21. This allows spring 15 to separate cutters 9 and 10 so that the weed may be ejected. The ejector consists of two metal strips 22 and 23 pressed apart by spring 24 so that the lower ends of the strips scrape the inside surface of the cutters. The ejector is operated by pushing down handle 25 and rod 26 carrying pivot 27 to which the strips are attached. Rod 16 is guided by passing through holes in pivots 13 and 14 and is shown in its lowest position. It is returned upwards by a spring, not shown, before commencing a new cycle of operations. Apparatus typical of class (3) will now be described.

The apparatus shown in Fig. XI depends partly on the action described above but in this case the disposition of the parts assists the directing action of the earth. The handle 1 is rigidly attached to a central tube or rod 2 which in turn is connected to the tubes 3 and 4 by the equal hinged links 5, 6, 7 and 8 in such manner that 2, 3 and 4 always remain parallel. The cutters 9 and 10 are placed with their points on the ground and then downward pressure on handle 1 forces the cutters into the soil until they converge and meet. As tubes 3 and 4 approach one another, the link 11, hinged on 4, engages by its teeth in a slot cut in the tube 3 so that the rods 3 and 4 cannot separate again, till the link 11 is lifted to disengage its teeth. The teeth are so cut that the link 11 lifts to let the successive teeth pass while rods 3 and 4 are closing. It will be noted that the downward movement of the handle 1 tends to draw tubes 3 and 4 together and so assists the inclined advance of the cutters in the ground.

Fig. XII illustrates a modification in which additional links 12 and 13 are employed to connect tubes 3 and 4 to tube 2 so that the cutters 9 and 10 are obliged to advance equally. The bottom of links 12 and 13 are pivotted to the tubes 3 and 4 respectively but the top ends are attached to a sliding member 15 which rides in slot 16 cut in tube 2. Part 15 is connected by rod 17 with a handle 18 and a one-way spring controlled cam friction grip 19 prevents rod 17 from any downward motion till the grip is released by pressing the knob 20. It will be seen that as the cutters 9 and 10 converge together sliding member 15 and rod 17 must move upwards and so the grip 19 holds the cutters closed until they are to be released and pushed apart by spring 21. The excavated weed is now ejected by pressing handle 22 downwards and causing rod 23, guide 24 and ejector blades 25 and 26 to push out the weed.

The scissor type of apparatus can take many forms according to the linkage system employed. It will suffice to describe that diagrammatically shewn in Fig. XIII in which the linkage chosen permits the use of half-cone cutters. The main levers 1, 2 and 3, 4, denoted by the numbers at their extremities, are pivoted together at 5. Links 6, 4 and 7, 2 are hinged or pivoted to the main levers at 4 and 2 respectively and are further connected by hinged links 6, 8 and 7, 9 as shown. The cutters 10 and 11 are forced into the ground by downward pressure on 1 and 3. In the example illustrated the chosen proportions of the lengths 5, 4: 4, 6: 6, 8 and 8, 5 are in the ratio 8, 10, 2 and 4 respectively and with these proportions the near edges of the cutters

will remain practically parallel while the cutters converge together in the ground. For linkages which cause the cutters to take curved paths through the ground the cutters should be shaped so that the path described by the leading point of a cutter is followed by the remainder of the cutter, so as to minimise earth displacement.

Cutters may take various shapes three suitable forms being shown in Fig. XIV where all have the same elevation but in plan are half-cone, angle, and rectangle respectively. Cutters may be constructed as forks with prongs either straight or bent, the latter being for cutters which are hinged. So far cutters have been shown converging till they meet but cutters may be made with projections or advanced cutting edges which overlap as shown in Fig. XV; it being understood that such advanced edges on one cutter are opposed to spaces in the other cutter. With cutters built up of prongs the overlap may be considerable, the prongs of one cutter passing through the spaces of the other cutter.

The only apparatus to be described as coming into Class 4 is that shown in Fig. XVI.

In hard ground it may be difficult by direct pressure to force the cutters into the ground. In such case the cutters may be rotated round an axis and provided with sharp cutting edges so as to cut their way into the ground while simultaneously rotating and descending. An example of such an apparatus is shown in Fig. XVI. A stationary handle 1 is attached to a vertical tube 2 which is fastened to a screw 3. Inside tube 2 is a sliding tube 4 which can be positioned by the handle 5 according to which side-slot 23 the handle is made to enter. The disc 6 at the end of tube 4 is centred on the weed to be removed and serves to carry the weight of the apparatus during operation. Fitting over tube 2 is a tube 7 attached at its top end to a bevel-wheel 8 and at its lower end fastened to two tubes 9 and 10 the straight portions of which acts as guides to the cutter arms 11 and 12 which slide inside them. A nut 13 threads on the screw 3 and has projections 14 and 15 slotted to engage pins 17 and 18 attached to cutters arms 11 and 12 respectively.

In operation bevel-wheel 8 is rotated by turning handle 19 and bevel pinion 20 carried from tube 2 thus revolving the cutters 21 and 22 and also the nut 13 which is thereby caused to move downwards carrying with it the arms 11 and 12 and the cutters 21 and 22. The cutters therefore make a spiral motion as they converge to meet in the ground and cut out a cone of earth containing the root to be extracted.

The common feature in the examples herein described is that they operate with the least displacement of the earth. When any solid body is introduced into the earth a displacement of the earth to make room for the body is essential and is accompanied by a small compression of the earth. Neglecting this unavoidable displacement and compression my invention enables converging cutters to operate without involving appreciable further displacement or compression and the operation may be characterised in a number of ways some of which I will now state

1. The work done against the resistance of the earth is a minimum.

2. The cutters converge so as to enclose a tapered plug of earth containing the weed etc. without substantially compressing the said plug or disturbing the surrounding earth.

3. The cutters converge so as to enclose a tapered plug of earth and the path described by the leading edge or point of each cutter is closely followed by the remainder of the cutter so as to minimise the displacement of earth.

4. The cutters follow or substantially follow the line of least resistance in their path through the earth.

5. Still another way of expressing the same idea is that the cutters may be considered as built up of a number of small sections straight or curved in the direction of advance. In the case of conical cutters the sections are all straight wedges. In the case of Fig. I the sections are all circular in shape and have their centres along a common axis. It is easy to see that as the cutters converge each straight section keeps its own straight line of advance and each circular section keeps its circular line of advance without deviating sideways. Thus compression of the earth is avoided.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is :—

1) Apparatus for extracting weeds, roots and the like from the ground, comprising two or more cutting members attached to a frame provided with a handle or handles or otherwise adapted to receive downwardly applied pressure to cause the cutting members to penetrate the ground, the said cutting members being mounted so that they converge as they penetrate the ground and thus enclose a tapered plug of earth containing the weed, etc., the converging movement being either a free movement caused solely by the

reaction of the soil or a constrained movement imposed by the mechanism of the frame or by both the frame mechanism and the said reaction, each cutting member in any case following a path in the ground which is a smooth continuation of the cutting surface so that the soil enclosed between the cutting members is not substantially compressed and also the surrounding earth is not disturbed.

2) A modification of the apparatus claimed in Claim 1, in which the cutting members are carried on arms which are pivoted as for example in Fig. VII or VIII of the accompanying drawings, the distance of the pivot (or pivots) above ground level when the cutting members are buried in the earth being greater than the effective length of the cutting members, in which case the cutting members follow substantially the line of least resistance.

3) Apparatus as claimed in Claim 1, in which means are provided for correctly positioning the apparatus relative to the ground prior to the operation of extracting the weed.

4) Apparatus as claimed in Claim 1, 2 or 3, in which means are provided for holding the cutting members in any desired relative position at any time during the cutting operation.

5) Apparatus as claimed in Claim 1, 2, 3 or 4, in which means are provided for ejecting the taper plug of soil containing the weed or the like from the cutting members after extraction from the ground.

6) Apparatus as claimed in Claim 1, in which the frame comprises a pair of pivoted radius arms, one of which is fixed to the lower end of a vertical handle which also carries one of the cutting members, while the other radius arm carries the second cutter which moves in a circular path to converge toward the first cutter.

7) Apparatus as claimed in Claim 1, comprising a central vertical member rigidly connecting a handle to a frame carrying two incline guides fitted with slidable members to which the cutters are attached, a slide guided by the central member and links connecting the slide to the two sliding members, a member concentric with the central member which is lifted or lowered in relation to the central member with the object of positioning the apparatus and of determining the distances between the cutters when they first enter the earth.

8) Apparatus as claimed in Claim 1, comprising a frame in two halves, pivotally connected at the top and carrying guides pivotally connected to the frame, said guides carrying sliding members rigidly attached to the cutters.

9) Apparatus as claimed in Claim 1, comprising a central vertical member rigidly attached to a frame which carries two inclined guides along which slide or roll, at right angles to the cutting direction, carriers rigidly attached to the cutters, means for moving the cutters so that the space between them is a chosen distance before the cutters enter the ground, and means for preventing the cutters from separating during a cutting cycle.

10) Apparatus as claimed in Claim 2, comprising two vertical members carrying cutters at their lower ends and hinged together at their upper ends and provided with handles, means for preventing the cutters from separating during a cutting cycle and means for opening the cutters and ejecting the weed.

11) Apparatus as claimed in Claim 2, comprising a central vertical member attached to a handle, a cross bar rigidly fixed to the central member, cutters attached to two members which are pivotally connected to the cross bar, a second handle rigidly attached to a member positioned at right angles to the central member which limits the distance between the two said members according to its vertical position and which carries ejector blades, the second handle and attachments being adapted to perform the following functions:—1) fix the distance between the cutters to that desired for any particular cycle; 2) prevent the cutters separating during a cutting cycle; 3) separate the cutters, and 4) eject the weed.

12) Apparatus as claimed in Claim 1, comprising two vertical members to which the cutters are rigidly fixed, cross links connecting the said members by means of pivots at their lower ends and pivots running in slots cut in the members at their upper ends, the links being pivotally connected at their common centre so that the two vertical members are constrained to remain parallel.

13) Apparatus as claimed in Claim 1, comprising two vertical members to which the cutters are rigidly attached and which are connected to two pairs of equal crossed links, each link being pivotally connected at one end to one member and carrying a pivot at the other end which slides in a slot in the other member, and each pair of links being pivotally connected at the common centre so that the parallel members are constrained to remain parallel; means for preventing the cutters from separating during a

cutting cycle and means for ejecting the weed.

14) Apparatus as claimed in Claim 1, comprising a central vertical member and two parallel side members to which the two cutters are rigidly attached, two pairs of inclined links pivotally connecting at their ends to the central member and side members respectively so that the side members are constrained to remain parallel.

15) Apparatus as claimed in Claim 1, comprising a central vertical member and two parallel side members to which the cutters are rigidly attached, two pairs of inclined links pivotally connecting the central and side members so that the latter are constrained to remain parallel, a further pair of links pivotally connected to a slide guided by the central member and pivotally connected to the side members so that the latter are constrained to advance equally during the cutter operation.

16) Apparatus as claimed in Claim 1, comprising two primary members pivoted together like a pair of scissors and pivotally connected at their lower extremities to two secondary members to which the cutters are rigidly attached, and links pivotally connecting the upper extremities of the secondary members to pivots on the primary members.

17) Apparatus as claimed in Claim 1, comprising a central vertical member rigidly attached to two inclined guides in which slide the members carrying the cutters, a cross bar carrying a nut coaxial with the central member, the cross bar having slotted ends engaging pins in the sliding members, a screw axially in line with the central member but carried independently thereof by means of a stationary handle, means of rotating the central member, guides, cutters and nut so that as the cutters revolve they are caused to descend by reason of the nut travelling down the screw and causing the cutters to cut a conical wedge of earth from the ground.

18) Apparatus for extracting roots, weeds, and the like, from the ground substantially as hereinbefore described with reference to each of the accompanying drawings.

Dated the 27th day of February, 1934.

H. A. HUMPHREY.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1934.

FIG. I.

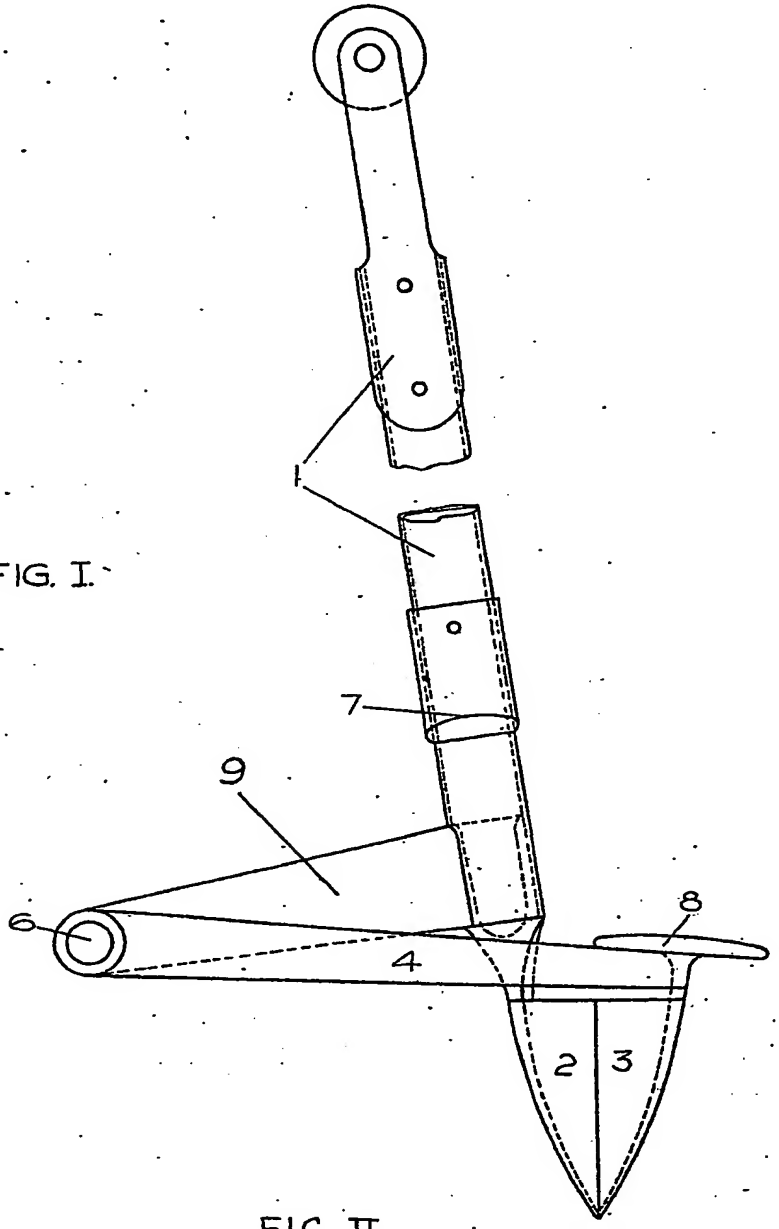
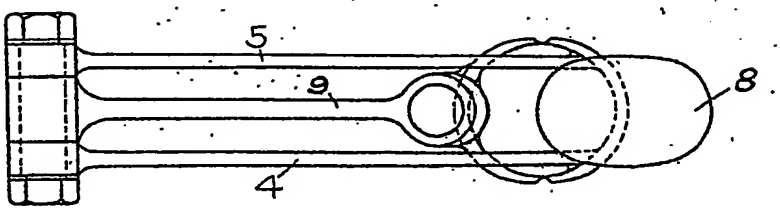


FIG II.



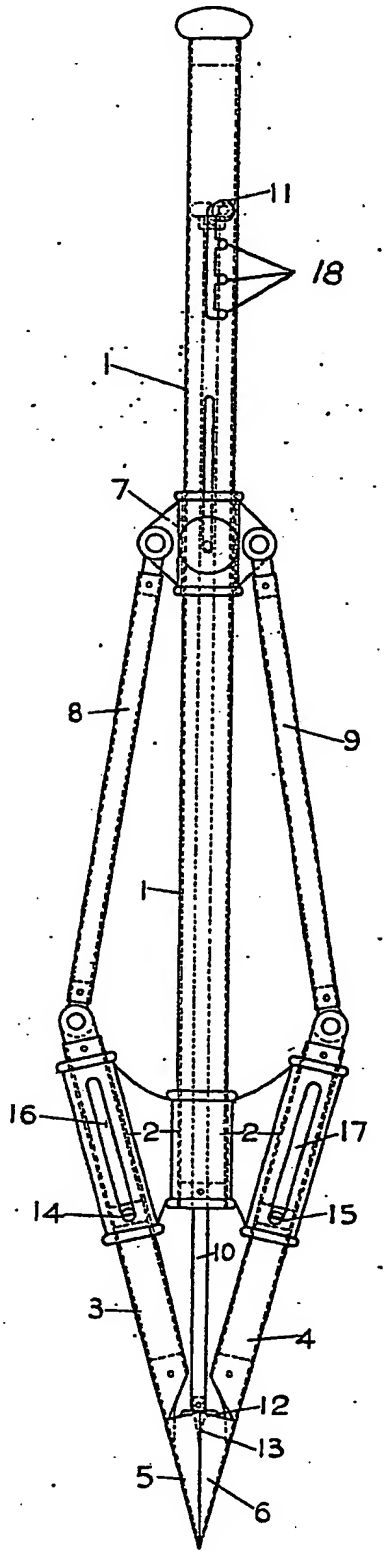


FIG. III

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412,407 COMPLETE SPECIFICATION

SHEET 1

11 SHEETS
SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. I.

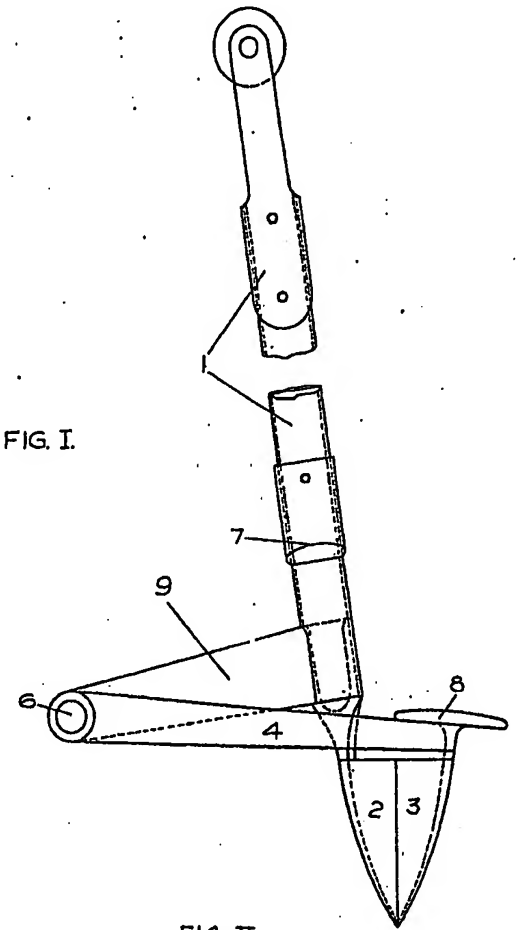
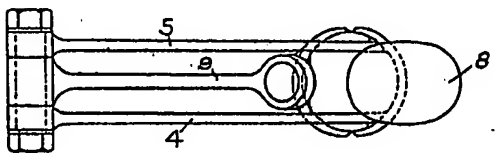


FIG II.



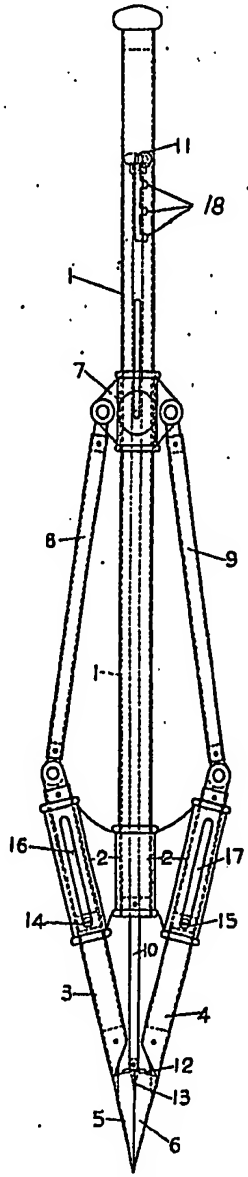


FIG. III.

Melby & Sons, Photo-Litho.

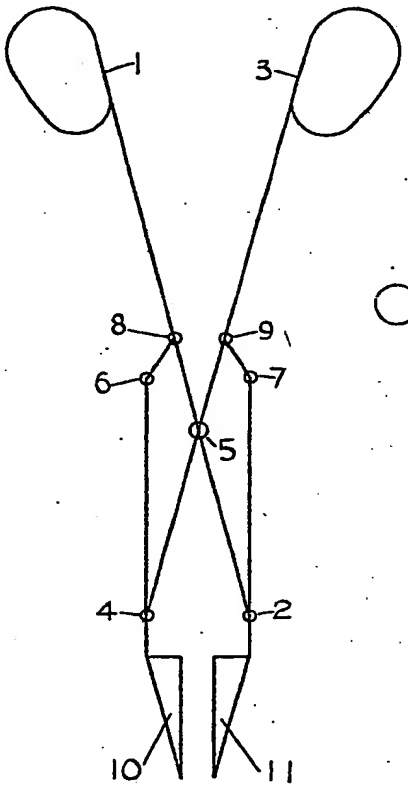


FIG. XIII

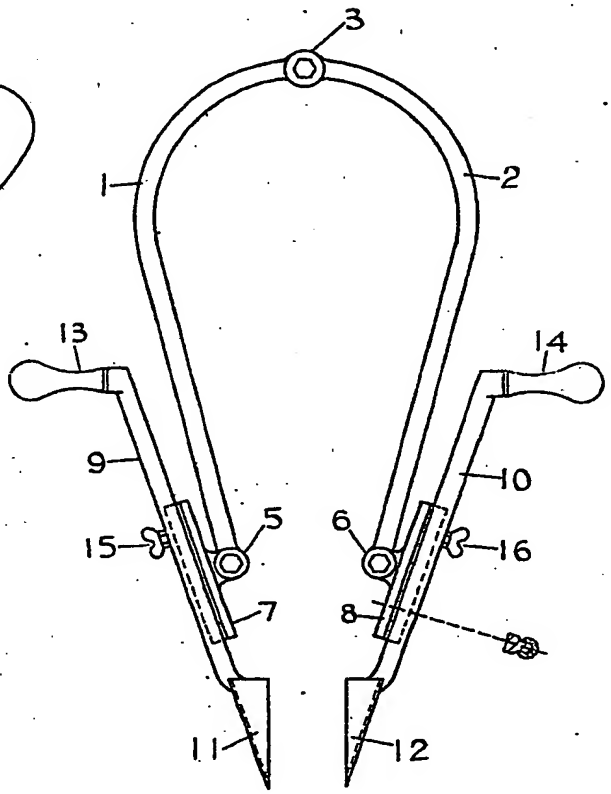
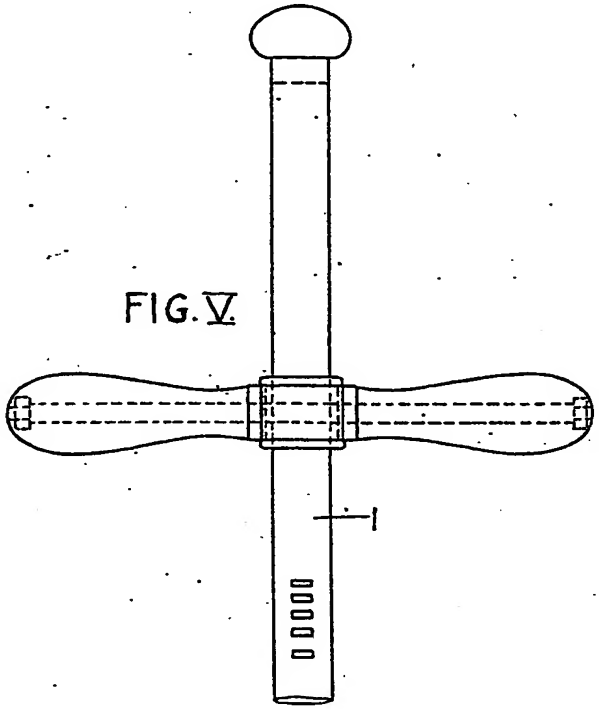
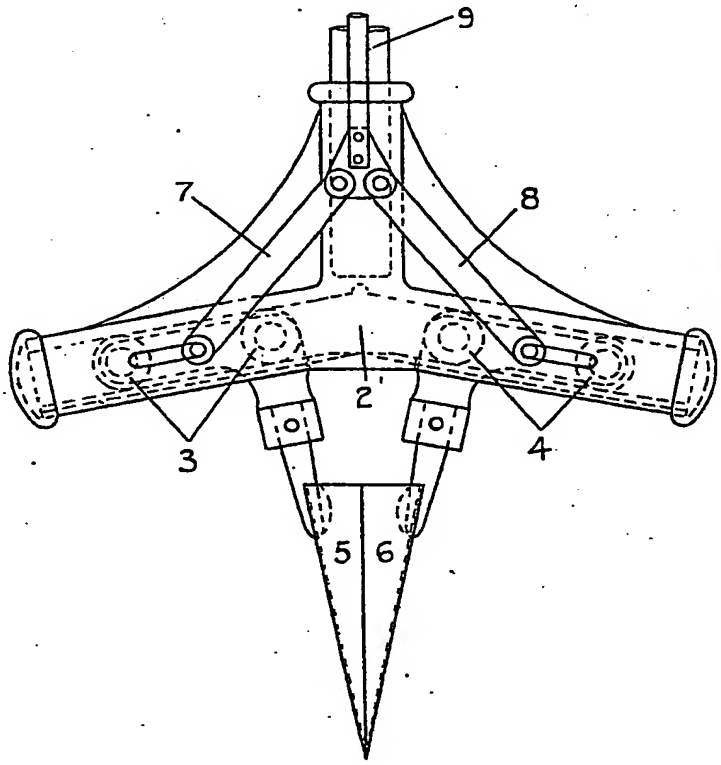


FIG. IV

FIG. V.





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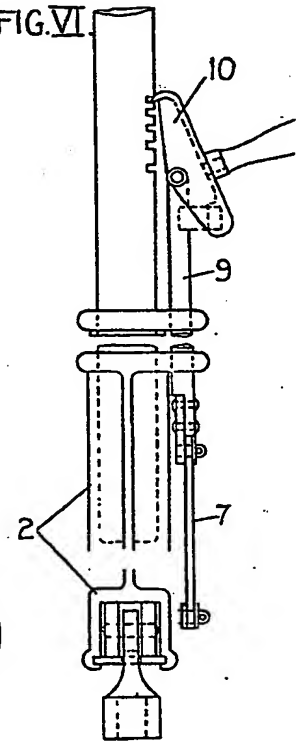

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11 SHEETS

SHEET 3

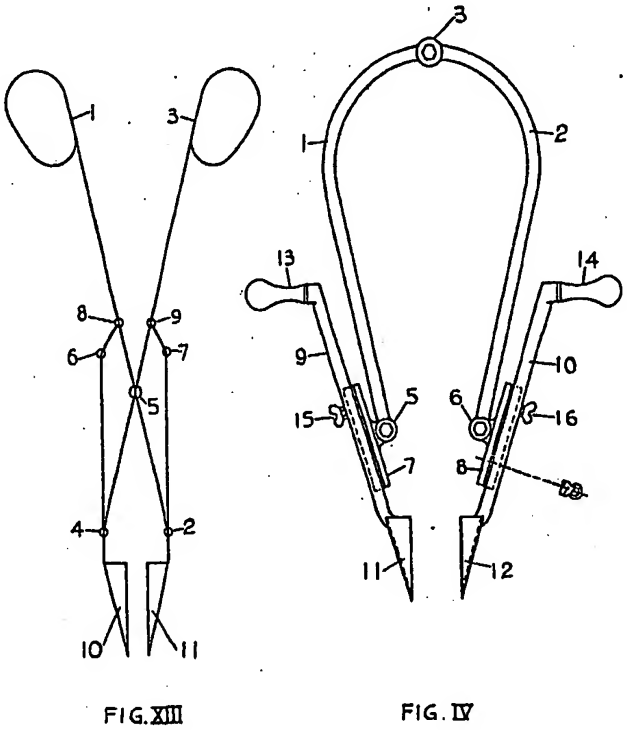
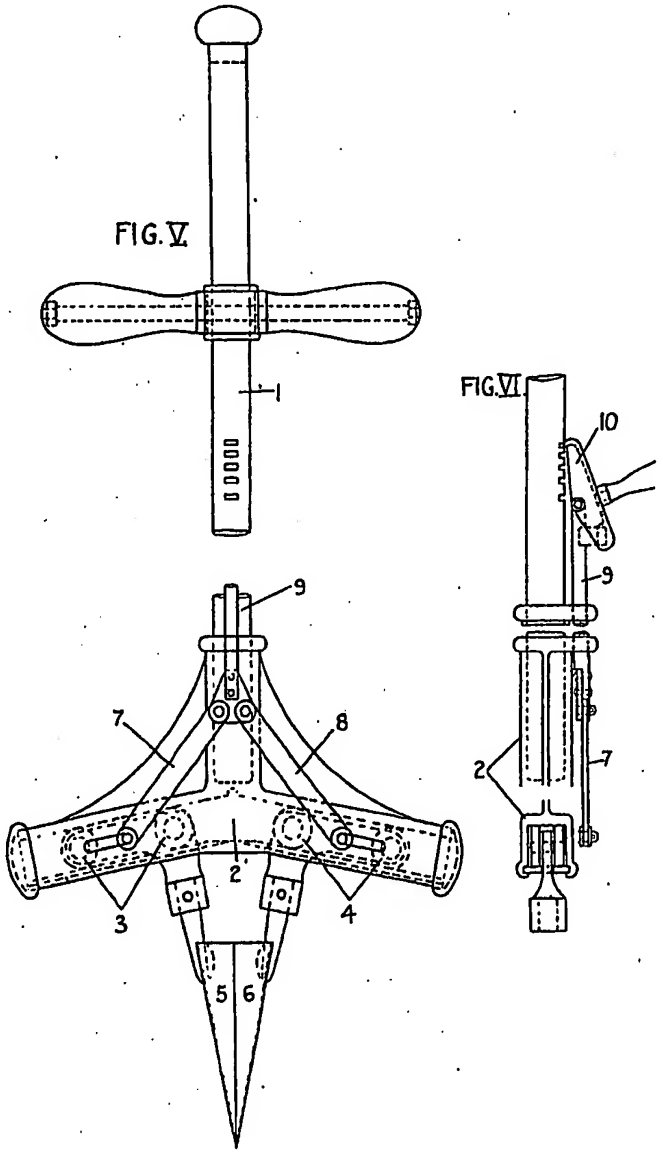


FIG. XIII

FIG. IV

[This Drawing is a reproduction of the Original on a reduced scale.]

SHEET 4



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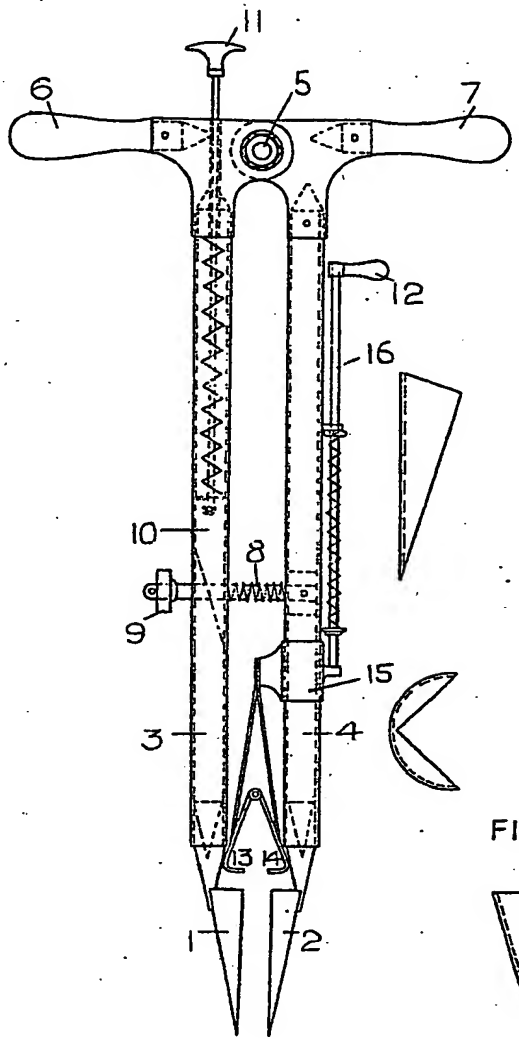


FIG. VII

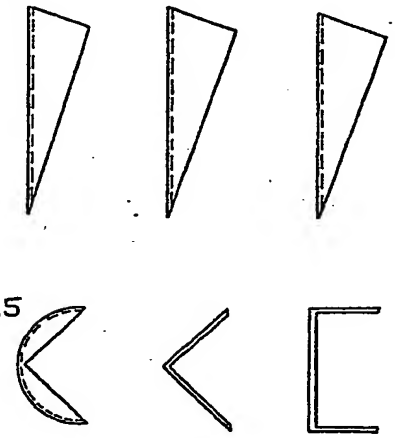


FIG. XIV

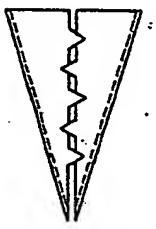
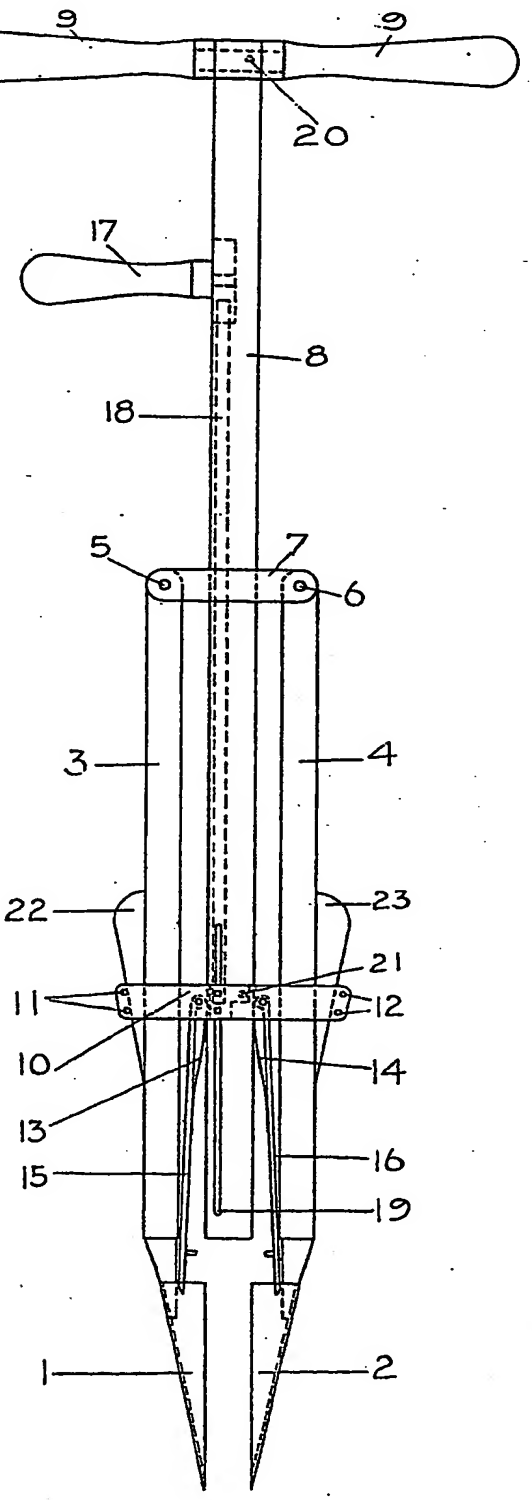


FIG. XV

FIG. VIII



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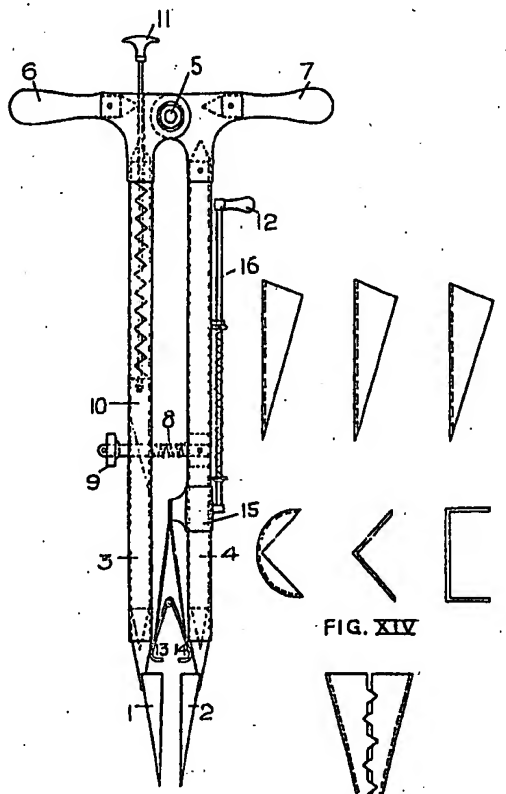

FIG. VII

FIG. XIV

FIG. XV

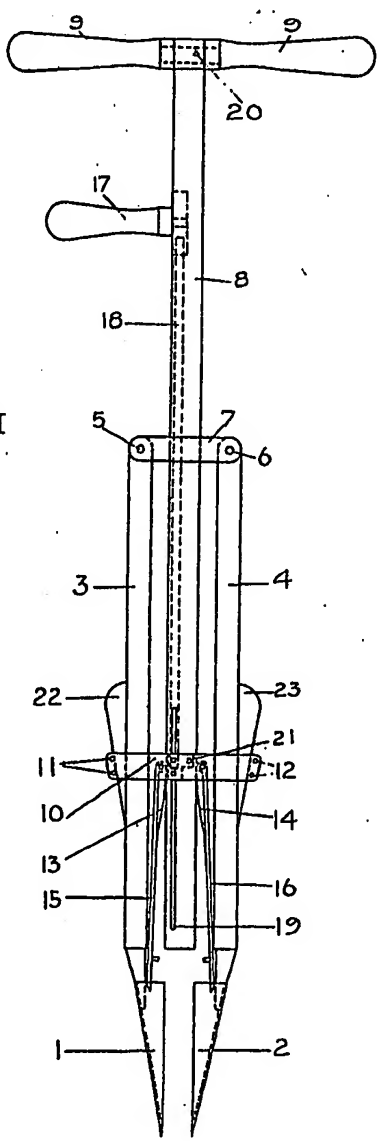

FIG. VIII

Malby & Sons, Photo-Litho

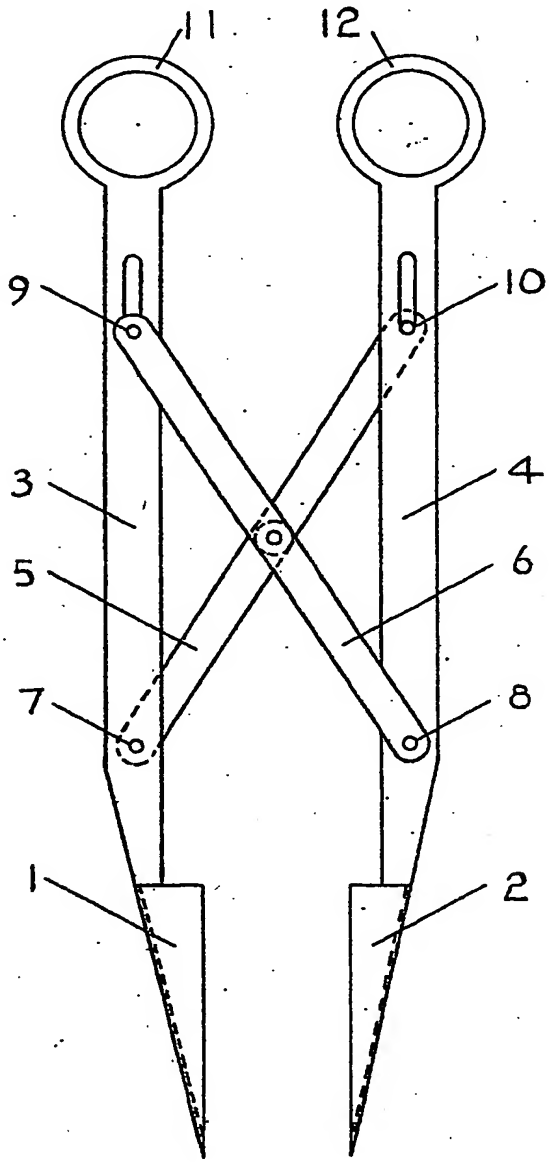

FIG. IX.

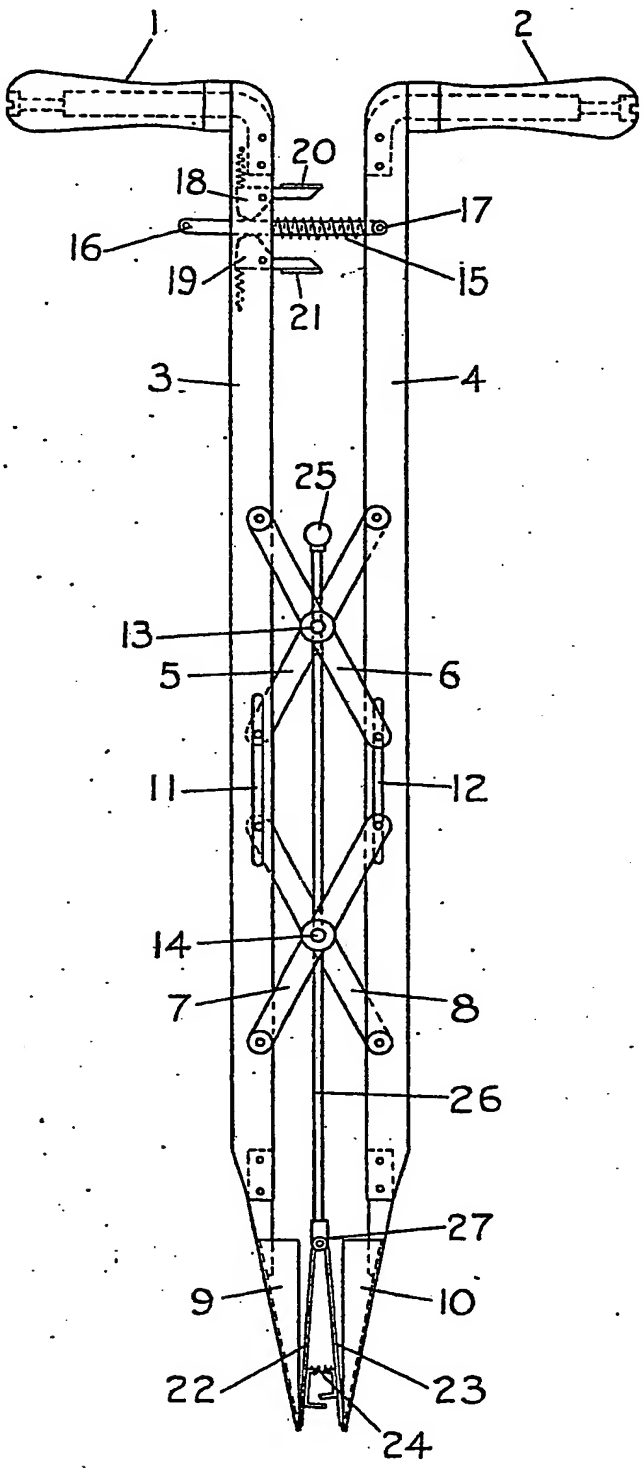

FIG X

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11 SHEETS

SHEET 7

[This Drawing is a reproduction of the Original on a reduced scale.]

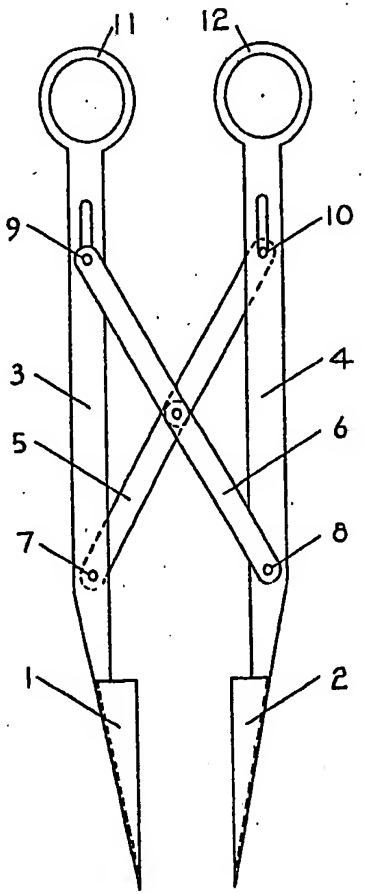

FIG. IX.

SHEET 8

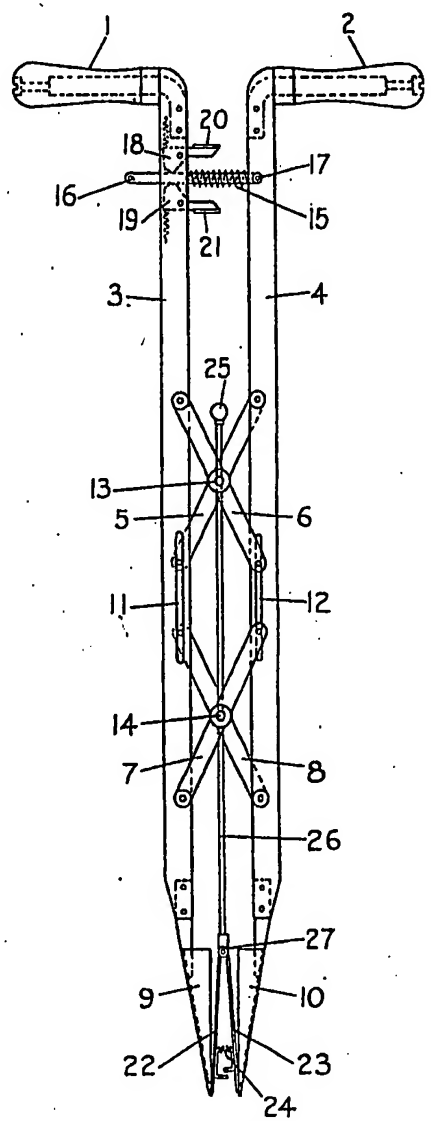

FIG X

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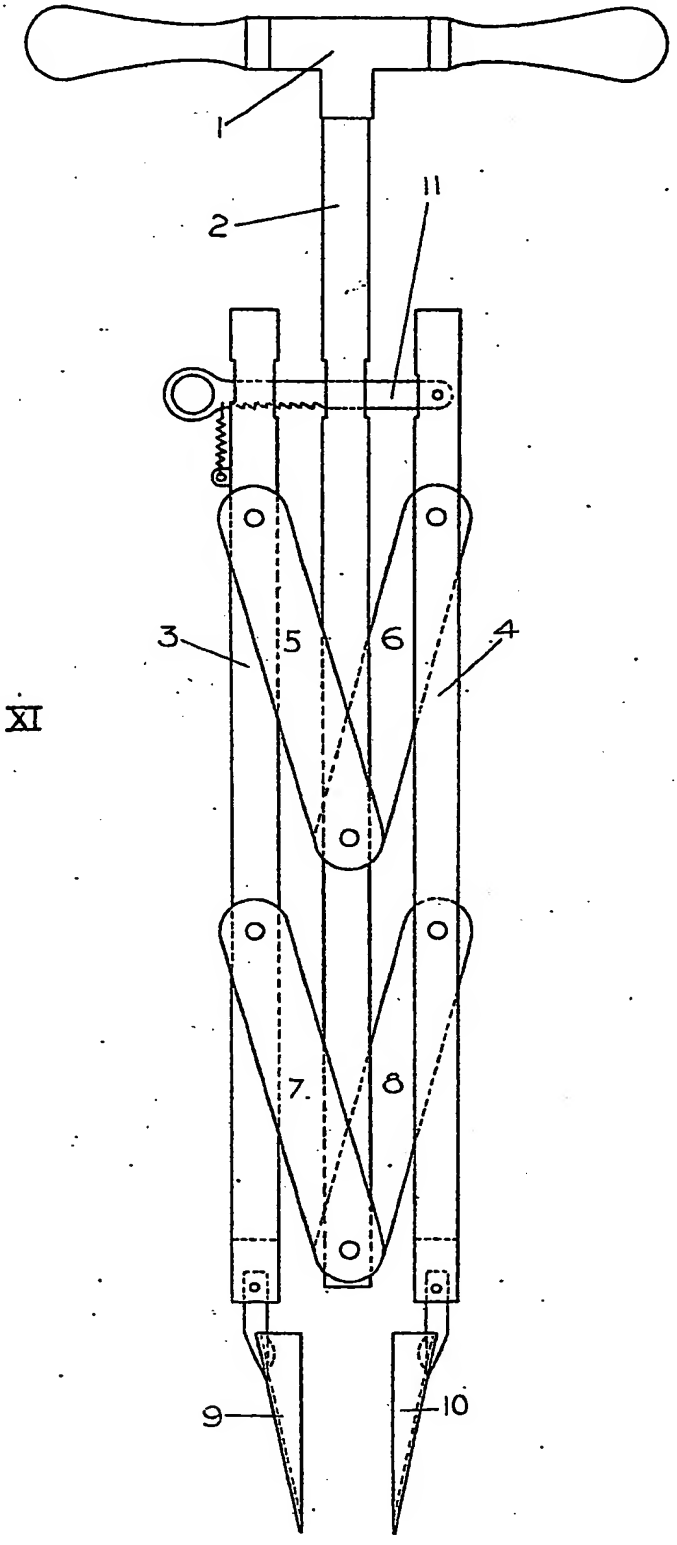

FIG. XI

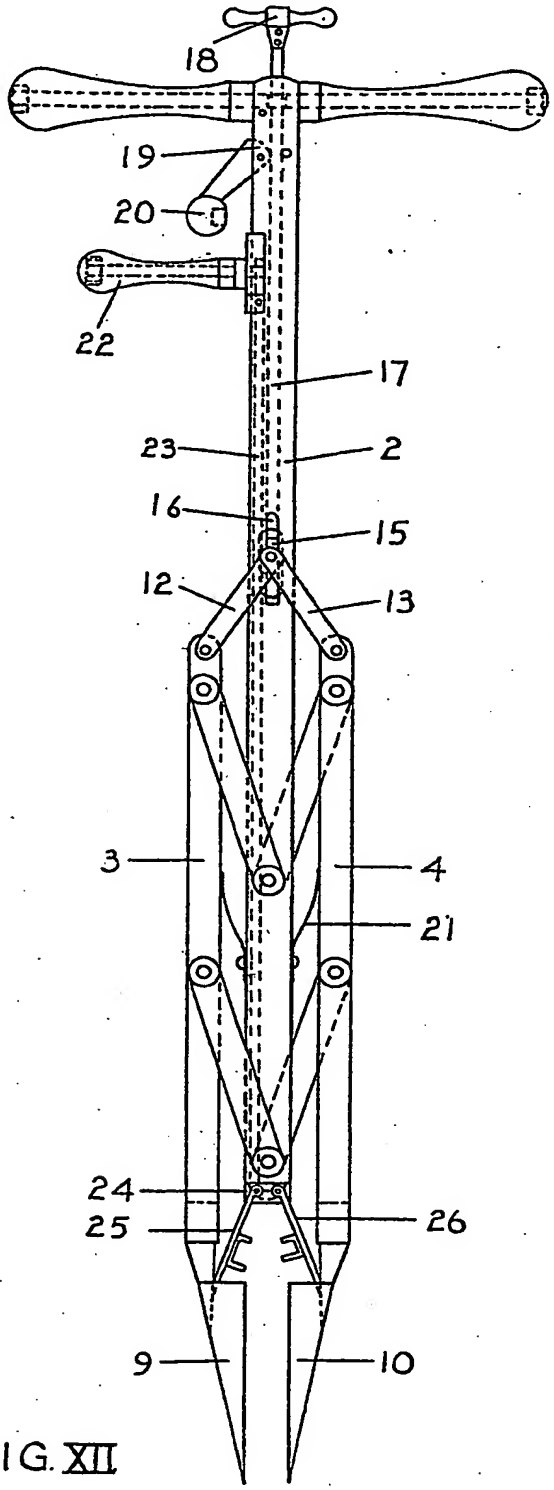

FIG. XII

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11 SHEETS

SHEET 9

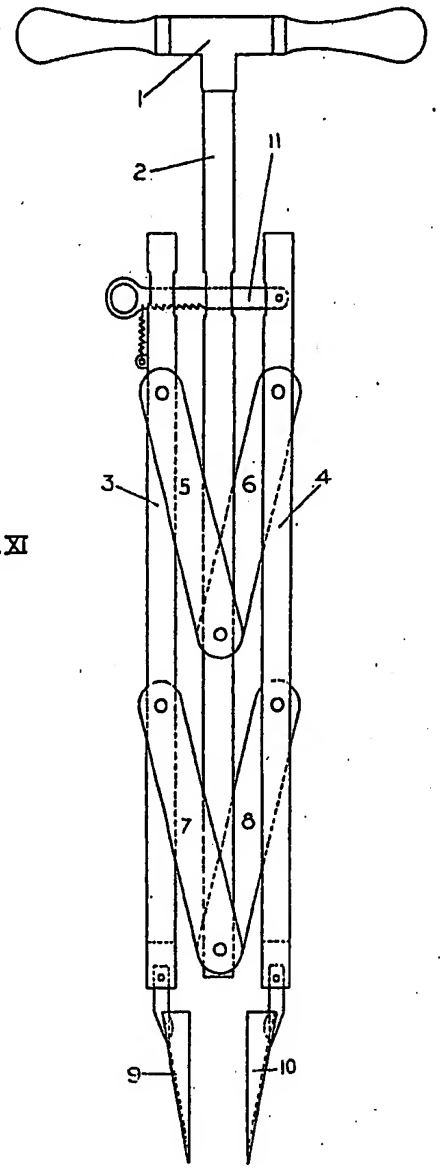

FIG. XI

SHEET 10

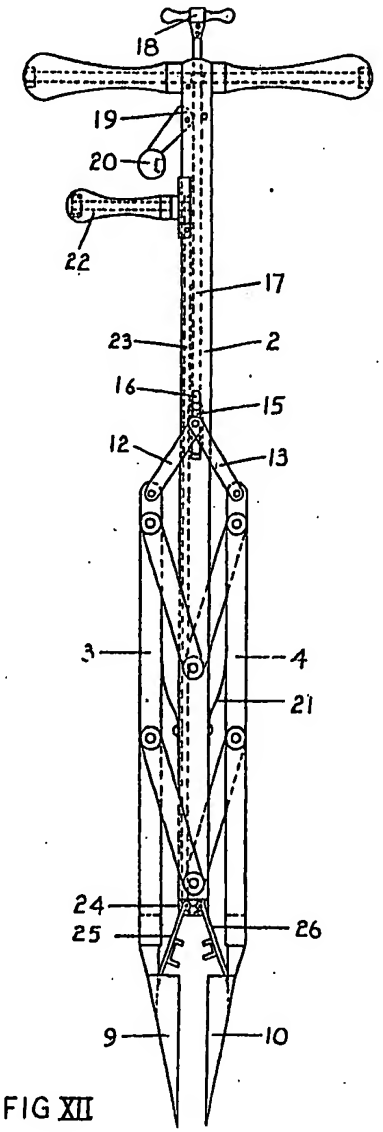

FIG XII

[This Drawing is a reproduction of the Original on a reduced scale.]

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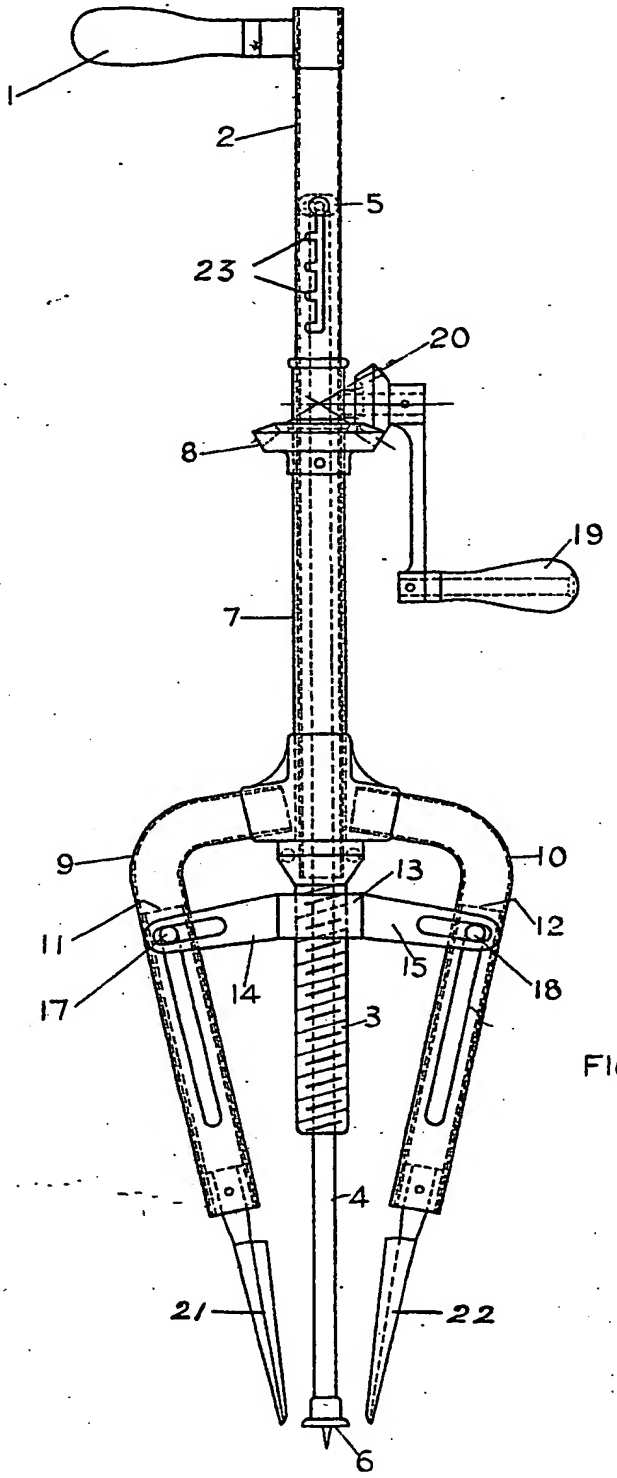

FIG. XVI.

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